



Total Dose Test Report

LM6144, 17MHz Rail to Rail Input-Output Op Amp

April 2003

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

JAYCOR, INC.

CUSTOMER: NASA/GSFC

NASA/GSFC P.O. #: 145590

PART NUMBER: LM6144

PACKAGE DATE CODE: 2001003-01, 0148

SERIAL NUMBERS: Jaycor Assigned 1-10

PART TYPE: 17MHz Rail to Rail Input-Output Op Amp

DIE MANUFACTURER: National Semiconductor

JAYCOR JOB NUMBER: 00456901-00000006

TEST DATE: August 7th – 22nd, 2002

TEST PERFORMED: Total Ionizing Dose

PREPARED BY:

Norman Hall Sr.

Norman Hall, Sr.
Radiation Testing Manager

ENGR. APPROVAL

Marion Rose
Division Reviewer



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INTRODUCTION

Jaycor, Inc. has performed total dose tolerance testing on the LM6144 17MHz Rail to Rail Input-Output Operational Amplifiers.. Testing was performed per MIL-STD-883, Test Methods 1019.4 and Method 1019.5 except as otherwise requested by NASA/GSFC.

PURPOSE

The results were used to qualify the National Semiconductor LM6144 17MHz Rail to Rail Input-Output Operational Amplifiers for total dose tolerance.

TEST FACILITY AND DOSIMETRY

Total dose testing was performed at the Defense Microelectronics Activity (DMEA) Science and Engineering Gamma Irradiation Test (SEGIT) Facility (Appendix A) located at McClellan, CA. The test samples were irradiated with a J.L. Shepherd & Associates Model 81-22/484 Serial No. 7125, 200 Curie ^{60}Co Source.

Dosimetry for all exposures was performed with Radcal Model No. 9010, Serial No.: 90-1313 and Radcal Ion Chamber Model No. 90X5-0.18, Serial No. 95-0478, calibrated 2 April 2002.

All dosimetry and test article irradiations were performed within an ASTM E1249-93 Pb/Al dose enhancement chamber to minimize errors in dosimetry due to low energy photons. Dosimetry was performed by placing a NIST traceable ion chamber in the test article positions, and taking the average of three readings recorded from an electronically matched radiation monitor after raising the appropriate ^{60}Co rod(s) into position.

TEST DEVICES

Ten devices were used for this test program. S/N five and seven were control samples and were never exposed to radiation at any time. S/N one through three, six, eight and nine were biased as shown in the bias circuit described in the test plan (Appendix B) while being irradiated.. S/N four and ten were unbiased during all irradiations as per instructions in the test plan. The devices were irradiated in two separate groups of four at a time. The first group consisted of S/N 1, 2, 3 and 4. The second group consisted of S/N 6, 8, 9, and 10.

TEST PROCEDURE

Irradiation occurred at an ambient temperature of $25^\circ\text{C} \pm 5^\circ\text{C}$ that is compliant to MIL-STD-883, Method 1019.5 paragraph 3.7.

The ten (10) units (eight test samples and two control samples) were electrically tested before irradiation and after the discrete total dose levels of: 2.5, 5, 10, 20, 30 and 50 KRad(Si) After the 50 Krad(Si) level, the parts were placed in a room temperature anneal for 168 hours (1 week). The parts were electrically tested for the final time after the 168 hour anneal.

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Eight (8) radiation test samples were irradiated in the total dose bias conditions shown in Appendix B. The power supply voltage remained constant for all radiation steps and the power supply current was allowed to vary. The total current was monitored during the irradiations.

The DUTs were irradiated and tested in the following sequence:

1. Pre-dose DC and AC tests.
2. Irradiate units at ~0.1 rad/sec. The dose rate was varied for each step such that all electrical measurements were performed during normal working hours (~7:00AM to 4:00PM).
3. Post irradiation electrical testing DC and AC tests.
4. Repeat steps 2 and 3 until final dose level.

Electrical testing was started within one hour from the end of the radiation exposure per step 3.10 (a) of MIL-STD-883, Test Method 1019.5. The time between the end of irradiation and the beginning of parametric measurements was kept constant at each step and was approximately 10 minutes.

All parametric data was taken with a TMT Inc. ASL-1000 Automatic Tester S/N A10191 calibrated 13 July 2002 and an HP3457A multimeter S/N 3114A12387 calibrated 22 April 2002.

TEST DATA and SUMMARY

Parametric tabular data is presented in Appendix C.

A chronological summary of the test results is provided below in Table 1 along with the identification numbers of those test articles that failed one or more electrical test specifications provided in the test plan. The irradiation time is the time and date formatted as (yyyymmdd).

The LM6144 17MHz Rail to Rail Input-Output Operational Amplifiers began to fail electrical specifications after a total dose of ~5 Krad(Si) and all had failed after receiving ~20 Krad(Si).

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Table 1, Test Results Summary

Irradiation Time	Electrical Measurement Time	Irradiated UUT ID#s	UUT ID#s Measured	Failed UUT ID#s	Total Dose krad(Si)
08:00 20020807 to 10:18:53 20020807	01:16:09 20020807		1,2,3,4,5,6,7,8,9,10		
12:18 20020807 to 14:36:53 20020807	10:23:56 20020807	1,2,3,4	1,2,3,4		2.552
	14:54:35 20020807	1,2,3,4	1,2,3,4		5.104
	10:24:50 20020808		5,6,7,8,9,10		
	13:25:11 20020808		5,6,7,8,9,10		
16:37 20020807 to 14:21:24 20020808	14:25:01 20020808	1,2,3,4	1,2,3,4	1	10.26
16:22 20020808 to 15:05:38 20020809	15:13:06 20020809	1,2,3,4	1,2,3,4	1,2,3,4	20.35
17:05 20020809 to 15:48:38 20020810	15:56:37 20020810	1,2,3,4	1,2,3,4	1,2,3,4	30.44
17:15 20020810 to 08:12:25 20020814	08:18:30 20020814	1,2,3,4	1,2,3,4	1,2,3,4	51.11
	09:03:37 20020815		5,7		
08:00 20020815 to 10:18:53 20020815	10:25:06 20020815	6,8,9,10	6,8,9,10		2.545
12:18 20020815 to 14:36:53 20020815	14:44:11 20020815	6,8,9,10	6,8,9,10	8	5.090
	14:06:38 20020816		5,7		
16:37 20020815 to 14:21:24 20020816	14:48:04 20020816	6,8,9,10	6,8,9,10	6,8	10.23
16:22 20020816 to 15:05:38 20020817	15:09:00 20020817	6,8,9,10	6,8,9,10	6,8,9,10	20.29
17:05 20020817 to 15:48:38 20020818	15:53:59 20020818	6,8,9,10	6,8,9,10	6,8,9,10	30.35
	11:03:39 20020821 (post anneal)		1,2,3,4	1,2,3,4	
17:15 20020818 to 08:12:25 20020822	08:14:15 20020822	6,8,9,10	6,8,9,10	6,8,9,10	50.96
	10:41:30 20020822		5,7		
	10:25:53 20020829 (post anneal)		5,6,7,8,9,10	6,8,9,10	

The actual electrical measurements are provided in Appendix C and identified by the electrical measurement times shown above. The estimated uncertainty at a 95% confidence level for the dosimetry is provided below in Table 2.

Table 2, Dosimetry/Uncertainty

Irradiation Time	Total Dose krad(SiO ₂)	Dose Step krad(SiO ₂)	Estimated Uncertainty	Dose Rate rad(Si)/m	Estimated Uncertainty
08:00 20020807 to 10:18:53 20020807	2.552	2.552	+/- 6.67%	18.38	+/- 6.60%
12:18 20020807 to 14:36:53 20020807	5.104	2.552	+/- 6.67%	18.38	+/- 6.60%
16:37 20020807 to 14:21:24 20020808	10.26	5.159	+/- 6.52%	3.955	+/- 6.45%
16:22 20020808 to 15:05:38 20020809	20.35	10.09	+/- 6.57%	7.399	+/- 6.50%
17:05 20020809 to 15:48:38 20020810	30.44	10.09	+/- 6.57%	7.396	+/- 6.50%
17:15 20020810 to 08:12:25 20020814	51.11	20.67	+/- 6.24%	3.962	+/- 6.17%
08:00 20020815 to 10:18:53 20020815	2.545	2.545	+/- 6.67%	18.32	+/- 6.60%
12:18 20020815 to 14:36:53 20020815	5.090	2.545	+/- 6.67%	18.32	+/- 6.60%
16:37 20020815 to 14:21:24 20020816	10.23	5.144	+/- 6.52%	3.944	+/- 6.45%
16:22 20020816 to 15:05:38 20020817	20.29	10.06	+/- 6.57%	7.378	+/- 6.50%
17:05 20020817 to 15:48:38 20020818	30.35	10.06	+/- 6.57%	7.375	+/- 6.50%
17:15 20020818 to 08:12:25 20020822	50.96	20.61	+/- 6.24%	3.950	+/- 6.17%

ANOMALIES

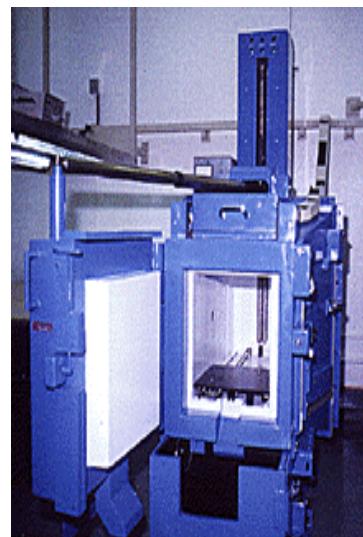
There was one deviation from the test plan. The control parts were not always tested after each irradiation step as required. This was discovered after the irradiations had begun. Once this discovery was made, the remaining irradiations were performed in accordance with the test plan.

As no significant deviations were seen in any tests of the control parts, it is Jaycor's opinion that the test data is valid. The V_{io} and I_{ib} data were taken with a bench test circuit and therefore not included in the spreadsheet with the rest of the data

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Appendix A
Science & Engineering Gamma Irradiation Test (SEGIT) Facility

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DMEA has an unequalled A2LA-accredited irradiation testing lab with its two gamma irradiators and associated equipment. These unique J.L. Shepherd model 81-22 self-contained irradiators, with customized model 484 exposure tunnels, are used to determine the effects of gamma radiation on microelectronic parts fabricated at DMEA, as well as on photonic components and systems. Both irradiators have dedicated data acquisition computers, optics tables, and measurement equipment for performing a wide variety of influx or step stressed experiments.

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**Appendix B
Test Plan
(NASA/GSFC Provided)**

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LM6144 TID test plan

Tested device

Part type	LM6144
Manufacturer	National Semiconductors
Function	17 MHz Rail to Rail Input-Output Operational Amplifier
Package	14 Flat Pack (To Be Confirmed)
Technology	bipolar
Package marking	
Number of parts	

Irradiation conditions

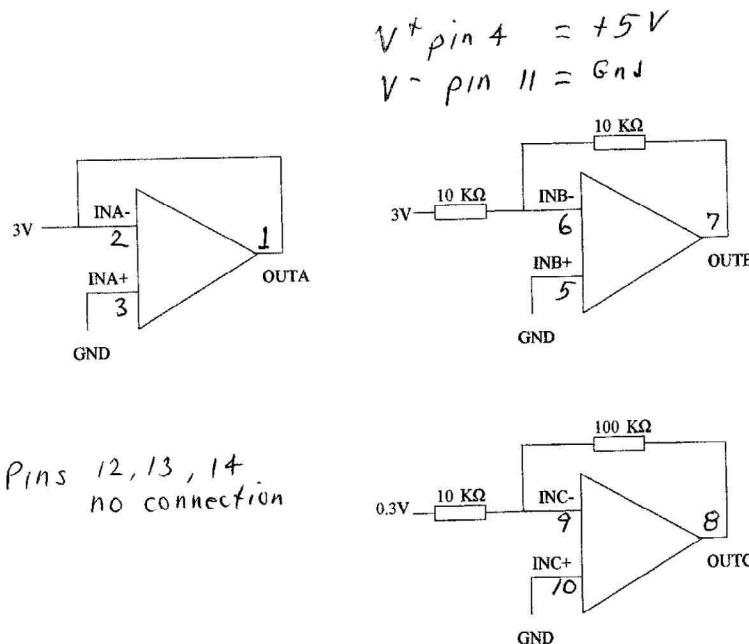
Source	Co60
Dose rate	~ 0.1 rad/s
Total Dose level	50 krad(Si)
Irradiation steps	2.5, 5, 10, 20, 30, 50 krad(Si)
Annealing step	168 hours at 25°C

Bias conditions

Six parts will have a static bias during irradiation as described in the Table below. Two parts will be irradiated with no bias applied.

Pin #	Pin name	Bias
1	OUT A	See bias schematics
2	- IN A	See bias schematics
3	+ IN A	See bias schematics
4	V+	+5V
5	+ IN B	See bias schematics
6	- IN B	See bias schematics
7	OUT B	See bias schematics
8	OUT C	See bias schematics
9	- IN C	See bias schematics
10	+ IN C	See bias schematics
11	V-	GND
12	+ IN D	NC
13	- IN D	NC
14	OUT D	NC

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Electrical measurements

$V_+ = 5V$, Unless Otherwise Specified.

Parameter	Symbol	Test Conditions	Min Limit	Max Limit	Units
Input Offset Voltage	V_{OS}			3.3	mV
Input Bias Current	I_B			300	nA
Common Mode Rejection Ratio	CMMR	$0V = V_{CM} = 5V$	64		dB
Power Supply rejection Ratio	PSSR	$5V = V+ = 24V$	78		dB
Large Signal Voltage Gain	A_v	$R_L = 10K\Omega$	25		V/mV
Output Swing	V_O	$R_L = 100K\Omega$	4.93		V
Slew Rate	SR	$8Vp-p @ Vcc 12V$ $R_S > 1k\Omega$	11		V/ μ s
Supply current	I_S	Per amplifier		880	μ A

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Appendix C
Tabular Test Data

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To view the entire worksheet in electronic format:

Place the cursor somewhere in the middle of the spreadsheet and double-click.
After viewing, click once outside the spreadsheet area to close.

Electrical Measurement Time	UUT ID#s	UUT ID#s Measured	UUT ID#s	krad(SiO ₂)	krad(SiO ₂)	Uncertainty	rad(SiO ₂)/s	Uncertainty
01:16:09 20020807		1,2,3,4,5,6,7,8,9,10						
10:23:56 20020807	1,2,3,4	1,2,3,4		2.552	2.552	+/- 6.67%	0.31	+/- 6.60%
14:54:35 20020807	1,2,3,4	1,2,3,4		5.104	2.552	+/- 6.67%	0.31	+/- 6.60%
10:24:50 20020808		5,6,7,8,9,10						
13:25:11 20020808		5,6,7,8,9,10						
14:25:01 20020808	1,2,3,4	1,2,3,4	1	10.26	5.159	+/- 6.52%	0.07	+/- 6.45%
15:13:06 20020809	1,2,3,4	1,2,3,4	1,2,3,4	20.35	10.09	+/- 6.57%	0.12	+/- 6.50%
15:56:37 20020810	1,2,3,4	1,2,3,4	1,2,3,4	30.44	10.09	+/- 6.57%	0.12	+/- 6.50%
08:18:30 20020814	1,2,3,4	1,2,3,4	1,2,3,4	51.11	20.67	+/- 6.24%	0.07	+/- 6.17%
09:03:37 20020815		5,7						
10:25:06 20020815	6,8,9,10	6,8,9,10		2.545	2.545	+/- 6.67%	0.31	+/- 6.60%
14:44:11 20020815	6,8,9,10	6,8,9,10	8	5.090	2.545	+/- 6.67%	0.31	+/- 6.60%
14:06:38 20020816		5,7						
14:48:04 20020816	6,8,9,10	6,8,9,10	6,8	10.23	5.144	+/- 6.52%	0.07	+/- 6.45%
15:09:00 20020817	6,8,9,10	6,8,9,10	6,8,9,10	20.29	10.06	+/- 6.57%	0.12	+/- 6.50%
15:53:59 20020818	6,8,9,10	6,8,9,10	6,8,9,10	30.35	10.06	+/- 6.57%	0.12	+/- 6.50%
11:03:39 20020821 (anneal)		1,2,3,4	1,2,3,4					
08:14:15 20020822	6,8,9,10	6,8,9,10	6,8,9,10	50.96	20.61	+/- 6.24%	0.070	+/- 6.17%
10:41:30 20020822		5,7						
10:25:53 20020829 (anneal)		5,6,7,8,9,10	6,8,9,10					
						Dosimetry is NIST traceable. Uncertainties are at a 95% confidence level.		

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The Following Data are Vio and Iib Measurements for the LM6144
LM6144 Vio and Iib Measurements Pre-Irradiation

IC# 1 A B C D

VOUT_S(mV) 3.706 3.948 3.506 17.45
VOUT_0(mV) 3.936 3.976 3.513 3.298
Vio(mV) 0.03706 0.03948 0.03506 0.1745
Iib(nA) -0.046 -0.0056 -0.0014 2.8304

IC# 2 A B C D

VOUT_S(mV) 3.647 21.56 3.317 3.214
VOUT_0(mV) 3.682 3.814 3.334 3.229
Vio(mV) 0.03647 0.2156 0.03317 0.03214
Iib(nA) -0.007 3.5492 -0.0034 -0.003

IC# 3 A B C D

VOUT_S(mV) 3.74 36.81 3.34 8.07
VOUT_0(mV) 3.741 3.868 3.367 3.264
Vio(mV) 0.0374 0.3681 0.0334 0.0807
Iio(nA) -0.0002 6.5884 -0.0054 0.9612

IC# 4 A B C D

VOUT_S(mV) 3.73 3.915 3.405 3.288
VOUT_0(mV) 3.734 3.921 3.411 3.294
Vio(mV) 0.0373 0.03915 0.03405 0.03288
Iib(nA) -0.0008 -0.0012 -0.0012 -0.0012

IC# 5 A B C D

VOUT_S(mV) 3.727 3.941 3.403 3.236
VOUT_0(mV) 3.731 3.946 3.403 3.23
Vio(mV) 0.03727 0.03941 0.03403 0.03236
Iib(nA) -0.0008 -0.001 0 0.0012

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IC# 6 A B C D

VOUT_S(mV) 3.726 3.93 3.437 3.326
VOUT_0(mV) 3.724 3.932 3.44 3.314
Vio(mV) 0.03726 0.0393 0.03437 0.03326
Iib(nA) 0.0004 -0.0004 -0.0006 0.0024

IC# 7 A B C D

VOUT_S(mV) 3.726 3.874 3.373 3.245
VOUT_0(mV) 3.735 3.88 3.364 3.247
Vio(mV) 0.03726 0.03874 0.03373 0.03245
Iib(nA) -0.0018 -0.0012 0.0018 -0.0004

IC# 8 A B C D

VOUT_S(mV) 20.96 3.892 3.375 3.357
VOUT_0(mV) 3.811 3.933 3.393 3.37
Vio(mV) 0.2096 0.03892 0.03375 0.03357
Iib(nA) 3.4298 -0.0082 -0.0036 -0.0026

IC# 9 A B C D

VOUT_S(mV) 0.16 3.812 3.364 3.265
VOUT_0(mV) 0.14 3.818 3.367 3.268
Vio(mV) 0.0016 0.03812 0.03364 0.03265
Iib(nA) 0.004 -0.0012 -0.0006 -0.0006

IC# 10 A B C D

VOUT_S(mV) 26.79 3.79 3.288 3.27
VOUT_0(mV) 3.659 3.817 3.303 3.26
Vio(mV) 0.2679 0.0379 0.03288 0.0327
Iib(nA) 4.6262 -0.0054 -0.003 0.002

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LM6144 Vio and Iib Measurements 2.5 Krad S/N 1-4

IC# 1 A B C D

VOUT_S(mV) 18.155 4.698 24.1 45.044

VOUT_0(mV) 4.591 4.775 4.332 4.208

Vio(mV) 0.18155 0.04698 0.241 0.45044

Iib(nA) 2.7128 -0.0154 3.9536 8.1672

IC# 2 A B C D

VOUT_S(mV) 4.552 40.32 8.718 4.138

VOUT_0(mV) 4.577 4.592 4.073 4.158

Vio(mV) 0.04552 0.4032 0.08718 0.04138

Iib(nA) -0.005 7.1456 0.929 -0.004

IC# 3 A B C D

VOUT_S(mV) 4.555 56.11 10.1 34.181

VOUT_0(mV) 4.59 4.639 4.16 4.205

Vio(mV) 0.04555 0.5611 0.101 0.34181

Iio(nA) -0.007 10.2942 1.188 5.9952

IC# 4 A B C D

VOUT_S(mV) 4.526 4.68 4.184 4.087

VOUT_0(mV) 4.575 4.707 4.2 4.092

Vio(mV) 0.04526 0.0468 0.04184 0.04087

Iib(nA) -0.0098 -0.0054 -0.0032 -0.001

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LM6144 Vio and Iib Measurements 5Krad S/N 1-4

IC# 1 A B C D

VOUT_S(mV) 32.428 5.609 47.171 65.68
VOUT_0(mV) 5.641 5.677 5.247 5.33
Vio(mV) 0.32428 0.05609 0.47171 0.6568
Iib(nA) 5.3574 -0.0136 8.3848 12.07

IC# 2 A B C D

VOUT_S(mV) 5.63 55.35 26.485 4.138
VOUT_0(mV) 5.707 5.481 4.94 5.251
Vio(mV) 0.0563 0.5535 0.26485 0.04138
Iib(nA) -0.0154 9.9738 4.309 -0.2226

IC# 3 A B C D

VOUT_S(mV) 5.645 68.9 26.36 52.66
VOUT_0(mV) 5.66 5.55 5.09 5.25
Vio(mV) 0.05645 0.689 0.2636 0.5266
Iio(nA) -0.003 12.67 4.254 9.482

IC# 4 A B C D

VOUT_S(mV) 5.55 5.65 5.13 5.05
VOUT_0(mV) 5.66 5.71 5.21 5.12
Vio(mV) 0.0555 0.0565 0.0513 0.0505
Iib(nA) -0.022 -0.012 -0.016 -0.014

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LM6144 Vio and Iib Measurements 10Krad S/N 1-4

IC# 1 A B C D

VOUT_S(mV) 44.9 7.169 78.758 92.588
VOUT_0(mV) 7.837 7.231 6.819 7.688
Vio(mV) 0.449 0.07169 0.78758 0.92588
Iib(nA) 7.4126 -0.0124 14.3878 16.98

IC# 2 A B C D

VOUT_S(mV) 24.9 67.78 48.4 7.477
VOUT_0(mV) 8.2 7.084 6.519 7.534
Vio(mV) 0.249 0.6778 0.484 0.07477
Iib(nA) 3.34 12.1392 8.3762 -0.0114

IC# 3 A B C D

VOUT_S(mV) 7.766 77.05 44.05 74.9
VOUT_0(mV) 8.034 7.143 6.692 7.48
Vio(mV) 0.07766 0.7705 0.4405 0.749
Iio(nA) -0.0536 13.9814 7.4716 13.484

IC# 4 A B C D

VOUT_S(mV) 7.688 38.45 7.208 38.042
VOUT_0(mV) 7.545 7.692 7.158 7.25
Vio(mV) 0.07688 0.3845 0.07208 0.38042
Iib(nA) 0.0286 6.1516 0.01 6.1584

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LM6144 Vio and Iib Measurements 20Krad S/N 1-4

IC# 1 A B C D

VOUT_S(mV) 44.44 9.977 63.673 144
VOUT_0(mV) 11.878 10.01 9.688 11.83
Vio(mV) 0.4444 0.09977 0.63673 1.44
Iib(nA) 6.5124 -0.0066 10.797 26.434

IC# 2 A B C D

VOUT_S(mV) 12.07 85.4 76.299 67.238
VOUT_0(mV) 12.248 9.903 9.303 11.8
Vio(mV) 0.1207 0.854 0.76299 0.67238
Iib(nA) -0.0356 15.0994 13.3992 11.0876

IC# 3 A B C D

VOUT_S(mV) 11.87 87.8 72.4 120.33
VOUT_0(mV) 11.84 9.99 9.56 11.445
Vio(mV) 0.1187 0.878 0.724 1.2033
Iio(nA) 0.006 15.562 12.568 21.777

IC# 4 A B C D

VOUT_S(mV) 65 84.99 77.4 85.63
VOUT_0(mV) 12.03 11.95 11.48 11.31
Vio(mV) 0.65 0.8499 0.774 0.8563
Iib(nA) 10.594 14.608 13.184 14.864

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LM6144 Vio and Iib Measurements 30Krad S/N 1-4

IC# 1 A B C D

VOUT_S(mV) 37.27 24.07 4.94 170
VOUT_0(mV) 15.18 12.21 4.94 15.31
Vio(mV) 0.3727 0.2407 0.0494 1.7
Iib(nA) 4.418 2.372 0 30.938

IC# 2 A B C D

VOUT_S(mV) 15.33 61.53 66.11 95.33
VOUT_0(mV) 15.97 11.93 11.33 14.95
Vio(mV) 0.1533 0.6153 0.6611 0.9533
Iib(nA) -0.128 9.92 10.956 16.076

IC# 3 A B C D

VOUT_S(mV) 15.34 61.25 64.69 164
VOUT_0(mV) 14.82 11.96 11.56 14.93
Vio(mV) 0.1534 0.6125 0.6469 1.64
Iio(nA) 0.104 9.858 10.626 29.814

IC# 4 A B C D

VOUT_S(mV) 85.77 72.27 85.17 68.3
VOUT_0(mV) 16.47 15.9 15.45 15.17
Vio(mV) 0.8577 0.7227 0.8517 0.683
Iib(nA) 13.86 11.274 13.944 10.626

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

LM6144 Vio and Iib Measurements 50Krad S/N 1-4

IC# 1 A B C D

VOUT_S(mV) 20 21.38 40.7 201.3
VOUT_0(mV) 19.65 14.41 14.22 19.6
Vio(mV) 0.2 0.2138 0.407 2.013
Iib(nA) 0.07 1.394 5.296 36.34

IC# 2 A B C D

VOUT_S(mV) 20.07 35.15 46.91 111
VOUT_0(mV) 19.66 14.02 13.41 19.2
Vio(mV) 0.2007 0.3515 0.4691 1.11
Iib(nA) 0.082 4.226 6.7 18.36

IC# 3 A B C D

VOUT_S(mV) 7.766 77.05 44.05 74.9
VOUT_0(mV) 8.034 7.143 6.692 7.48
Vio(mV) 0.07766 0.7705 0.4405 0.749
Iio(nA) -0.0536 13.9814 7.4716 13.484

IC# 4 A B C D

VOUT_S(mV) 7.688 38.45 7.208 38.042
VOUT_0(mV) 7.545 7.692 7.158 7.25
Vio(mV) 0.07688 0.3845 0.07208 0.38042
Iib(nA) 0.0286 6.1516 0.01 6.1584

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

LM6144 Vio and Iib Measurements 50Krad + 1 Wk S/N 1-4

IC# 1 A B C D

VOUT_S(mV) 20 24.31 53.7 198

VOUT_0(mV) 19.5 15.31 15.22 19.8

Vio(mV) 0.2 0.2431 0.537 1.98

Iib(nA) 0.1 1.8 7.696 35.64

IC# 2 A B C D

VOUT_S(mV) 0.31 44.75 58.31 105.37

VOUT_0(mV) 0.27 14.96 14.34 19.53

Vio(mV) 0.0031 0.4475 0.5831 1.0537

Iib(nA) 0.008 5.958 8.794 17.168

IC# 3 A B C D

VOUT_S(mV) 19.42 43.79 58.4 191

VOUT_0(mV) 18.98 14.92 14.54 19.86

Vio(mV) 0.1942 0.4379 0.584 1.91

Iio(nA) 0.088 5.774 8.772 34.228

IC# 4 A B C D

VOUT_S(mV) 0.06 0.04 0.01 0.01

VOUT_0(mV) 0.1 0.04 0.01 0.01

Vio(mV) 0.0006 0.0004 0.0001 0.0001

Iib(nA) -0.008 0 0 0

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

LM6144 Vio and Iib Measurements 2.5K 6-10

IC# 6 A B C D

VOUT_S(mV) 15.37 4.69 4.2 21.77

VOUT_0(mV) 4.54 4.75 4.25 4.19

Vio(mV) 0.1537 0.0469 0.042 0.2177

Iib(nA) 2.166 -0.012 -0.01 3.516

IC# 8 A B C D

VOUT_S(mV) 56.5 15.35 64.47 22.77

VOUT_0(mV) 4.7 4.54 4.07 4.29

Vio(mV) 0.565 0.1535 0.6447 0.2277

Iib(nA) 10.36 2.162 12.08 3.696

IC# 9 A B C D

VOUT_S(mV) 4.49 4.58 4.15 4.22

VOUT_0(mV) 4.49 4.58 4.15 4.2

Vio(mV) 0.0449 0.0458 0.0415 0.0422

Iio(nA) 0 0 0 0.004

IC# 10 A B C D

VOUT_S(mV) 53.61 4.55 4.05 21.27

VOUT_0(mV) 4.48 4.61 4.08 4.06

Vio(mV) 0.5361 0.0455 0.0405 0.2127

Iib(nA) 9.826 -0.012 -0.006 3.442

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

LM6144 Vio and Iib Measurements 5K 6-10

IC# 6 A B C D

VOUT_S(mV) 31.1 5.59 5.08 43.43

VOUT_0(mV) 5.47 5.67 5.14 5.15

Vio(mV) 0.311 0.0559 0.0508 0.4343

Iib(nA) 5.126 -0.016 -0.012 7.656

IC# 8 A B C D

VOUT_S(mV) 78.6 54.16 86.35 54.38

VOUT_0(mV) 5.75 5.2 4.79 5.4

Vio(mV) 0.786 0.5416 0.8635 0.5438

Iib(nA) 14.57 9.792 16.312 9.796

IC# 9 A B C D

VOUT_S(mV) 5.46 5.42 5 5.17

VOUT_0(mV) 5.49 5.42 5 5.2

Vio(mV) 0.0546 0.0542 0.05 0.0517

Iio(nA) -0.006 0 0 -0.006

IC# 10 A B C D

VOUT_S(mV) 73.67 5.5 27.2 41.26

VOUT_0(mV) 5.44 5.54 5 5.01

Vio(mV) 0.7367 0.055 0.272 0.4126

Iib(nA) 13.646 -0.008 4.44 7.25

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

LM6144 Vio and Iib Measurements 10K 6-10

IC# 6 A B C D

VOUT_S(mV) 44.89 19.85 6.69 73.54
VOUT_0(mV) 7.49 7.33 6.75 7.21
Vio(mV) 0.4489 0.1985 0.0669 0.7354
Iib(nA) 7.48 2.504 -0.012 13.266

IC# 8 A B C D

VOUT_S(mV) 71.15 47.18 74.83 90.7
VOUT_0(mV) 8 6.43 6.1 7.54
Vio(mV) 0.7115 0.4718 0.7483 0.907
Iib(nA) 12.63 8.15 13.746 16.632

IC# 9 A B C D

VOUT_S(mV) 7.73 6.97 6.57 7.38
VOUT_0(mV) 7.57 6.97 6.56 7.35
Vio(mV) 0.0773 0.0697 0.0657 0.0738
Iio(nA) 0.032 0 0.002 0.006

IC# 10 A B C D

VOUT_S(mV) 99.34 35.4 56.1 67.79
VOUT_0(mV) 7.53 7.64 7.02 7.06
Vio(mV) 0.9934 0.354 0.561 0.6779
Iib(nA) 18.362 5.552 9.816 12.146

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

LM6144 Vio and Iib Measurements 20K 6-10

IC# 6 A B C D

VOUT_S(mV) 58.56 48.2 37.92 131.7
VOUT_0(mV) 11.39 10.25 9.6 11.54
Vio(mV) 0.5856 0.482 0.3792 1.317
Iib(nA) 9.434 7.59 5.664 24.032

IC# 8 A B C D

VOUT_S(mV) 40.11 38.99 61.22 102.77
VOUT_0(mV) 12.36 9.01 8.82 12.25
Vio(mV) 0.4011 0.3899 0.6122 1.0277
Iib(nA) 5.55 5.996 10.48 18.104

IC# 9 A B C D

VOUT_S(mV) 11.27 9.74 31.7 48.19
VOUT_0(mV) 11.55 9.8 9.4 11.29
Vio(mV) 0.1127 0.0974 0.317 0.4819
Iio(nA) -0.056 -0.012 4.46 7.38

IC# 10 A B C D

VOUT_S(mV) 155.87 91.8 113.2 116.88
VOUT_0(mV) 11.95 11.83 11.8 11.08
Vio(mV) 1.5587 0.918 1.132 1.1688
Iib(nA) 28.784 15.994 20.28 21.16

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
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LM6144 Vio and Iib Measurements 30K 6-10

IC# 6 A B C D

VOUT_S(mV) 37.01 44.51 48.57 144.53
VOUT_0(mV) 14.47 12.27 11.56 14.72
Vio(mV) 0.3701 0.4451 0.4857 1.4453
Iib(nA) 4.508 6.448 7.402 25.962

IC# 8 A B C D

VOUT_S(mV) 29.07 0.11 0.03 113.76
VOUT_0(mV) 16.68 0.14 0.02 15.16
Vio(mV) 0.2907 0.0011 0.0003 1.1376
Iib(nA) 2.478 -0.006 0.002 19.72

IC# 9 A B C D

VOUT_S(mV) 14.77 11.76 44.46 91.75
VOUT_0(mV) 14.37 11.8 11.42 14.88
Vio(mV) 0.1477 0.1176 0.4446 0.9175
Iio(nA) 0.08 -0.008 6.608 15.374

IC# 10 A B C D

VOUT_S(mV) 155.87 97.01 109.85 118.55
VOUT_0(mV) 15.12 15.1 14.39 14.32
Vio(mV) 1.5587 0.9701 1.0985 1.1855
Iib(nA) 28.15 16.382 19.092 20.846

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

LM6144 Vio and Iib Measurements 50K 6-10

IC# 6 A B C D

VOUT_S(mV) 0.04 38.86 37.66 0.03

VOUT_0(mV) 0.04 14.4 13.62 0.03

Vio(mV) 0.0004 0.3886 0.3766 0.0003

Iib(nA) 0 4.892 4.808 0

IC# 8 A B C D

VOUT_S(mV) 0.02 0.04 0.02 0.02

VOUT_0(mV) 0.02 0.04 0.02 0.02

Vio(mV) 0.0002 0.0004 0.0002 0.0002

Iib(nA) 0 0 0 0

IC# 9 A B C D

VOUT_S(mV) 0.04 0.06 0.03 0.03

VOUT_0(mV) 0.04 0.06 0.03 0.03

Vio(mV) 0.0004 0.0006 0.0003 0.0003

Iio(nA) 0 0 0 0

IC# 10 A B C D

VOUT_S(mV) 0.04 0.06 0.03 0.03

VOUT_0(mV) 0.04 0.06 0.03 0.03

Vio(mV) 0.0004 0.0006 0.0003 0.0003

Iib(nA) 0 0 0 0

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

LM6144 Vio and Iib Measurements 50K + 1wk S/N 6-10

IC# 5 A B C D

VOUT_S(mV) 3.71 3.92 3.39 3.22

VOUT_0(mV) 3.71 3.93 3.39 3.22

Vio(mV) 0.0371 0.0392 0.0339 0.0322

Iib(nA) 0 -0.002 0 0

IC# 6 A B C D

VOUT_S(mV) 0.03 37.45 44.81 0.02

VOUT_0(mV) 0.03 15.3 14.57 0.02

Vio(mV) 0.0003 0.3745 0.4481 0.0002

Iib(nA) 0 4.43 6.048 0

IC# 7 A B C D

VOUT_S(mV) 3.72 3.87 3.35 3.24

VOUT_0(mV) 3.72 3.86 3.36 3.24

Vio(mV) 0.0372 0.0387 0.0335 0.0324

Iio(nA) 0 0.002 -0.002 0

IC# 8 A B C D

VOUT_S(mV) 0.01 0.06 0.01 0.01

VOUT_0(mV) 0.01 0.06 0.01 0.01

Vio(mV) 0.0001 0.0006 0.0001 0.0001

Iib(nA) 0 0 0 0

IC# 9 A B C D

VOUT_S(mV) 0.02 0.05 0.02 0.02

VOUT_0(mV) 0.02 0.05 0.02 0.02

Vio(mV) 0.0002 0.0005 0.0002 0.0002

Iib(nA) 0 0 0 0

Total Dose Test Report
LM6144, 17MHz Rail to Rail Input-Output Op Amp
April, 2003

IC# 10 A B C D

VOUT_S(mV) 0.04 0.07 0.02 0.03

VOUT_0(mV) 0.04 0.07 0.02 0.03

Vio(mV) 0.0004 0.0007 0.0002 0.0003

Iib(nA) 0 0 0 0